BRITISH MUSEUM (NATURAL HISTORY)

SPECIAL GUIDE No. 7

GUIDE TO THE SPECIMENS
AND ENLARGED MODELS OF

INSECTS

AND TICKS EXHIBITED IN THE

CENTRAL HALL

ILLUSTRATING THEIR IMPORTANCE
IN THE SPREAD OF

DISEASE

LONDON
PRINTED BY ORDER OF THE TRUSTEES
OF THE BRITISH MUSEUM
1916

[PRICE SIXPENCE]

BRITISH MUSEUM (NATURAL HISTORY)

SPECIAL GUIDE No. 7

GUIDE TO THE SPECIMENS AND ENLARGED MODELS OF

INSECTS

AND TICKS EXHIBITED IN THE

CENTRAL HALL

ILLUSTRATING THEIR IMPORTANCE IN THE SPREAD OF

DISEASE

LONDON

PRINTED BY ORDER OF THE TRUSTEES OF THE BRITISH MUSEUM

1916

LONDON:
PRINTED BY WILLIAM CLOWES AND SONS, LIMITED,
DUKE STREET, STAMFORD STREET, S.E., AND GREAT WINDMILL STREET,

10 H

PREFACE.

The method of explaining to visitors the general appearance and the details of the external features of insects by means of models on a large scale, rather than by the more customary drawings, was first adopted by Sir E. Ray Lankester, Director of the Museum, in the year 1900. The earliest models were those of two mosquitoes and a tsetse-fly. After Sir Ray Lankester's retirement in December 1907, the method was followed up by the preparation of a model of a flea (presented by the Entomological Research Committee); more recently, models of a house-fly and a tick have been added. During the present year the series of disease-spreading insects and ticks has been further increased by placing on view a collection of specimens and models of tsetse-flies, tabanid flies, mosquitoes and ticks; this collection was prepared, on behalf of the Exhibitions Branch of the Board of Trade, in 1913, under the direction of Mr. E. E. Austen, Assistant in the Department of Entomology, and was shown in the "Tropical Diseases" Section of the International Exhibition at Ghent in the summer of that year. The models have been kindly lent to the Museum by the Board.

Only those insects and ticks that are of importance in the spread of disease have been selected for exhibition in the middle of the Central Hall; the general series of insects and ticks is to be found in the Arthropod Gallery, in the West Wing of the Museum; the collection of insects injurious to crops is exhibited in the North Hall.

The large models shown in the Hall were constructed under the supervision of expert entomologists by Mrs. E. D. Blackman and Miss Grace Edwards, and so far as is possible they are correct in the smallest details.

The present guide-book is to a large extent a compilation, made by Dr. W. G. Ridewood, of the exhibited labels that accompany the insects and the models.

The acknowledgments of the Trustees are due to Drs. Castellani and Chalmers for permission to use the figures of the house-fly, bed-bug and tick given in their Manual of Tropical Medicine.

L. FLETCHER,
Director.

British Museum (Natural History),
December, 1915.

TABLE OF CONTENTS.

LIST OF ILLUSTRATIONS.

INSECTS AND TICKS AND THEIR IMPORTANCE IN THE SPREAD OF DISEASE.

INTRODUCTION.

THE entrance to the museum is at the South end of the Central Hall, and the main staircase at the North end; the side of the Hall to the right of the visitor as he enters is the East. The Bays or Recesses around the Hall are designated by numerals, painted below the end windows. On the East side the most southern bay, that near the statue of Prof. Huxley, is No. X; on the West side the southern bay, with the bust of Sir William Flower against the arch, is No. I.

The grouping of the objects in the following pages is one based upon the systematic position of the insects themselves, and not according to the sequence of the show-cases in which they are exhibited. This arrangement has the effect of causing a visitor who reads the pages consecutively to walk away from a case before exhausting it, and to return to the case later in order to see other insects contained in it; but the method has the advantage of preventing any mental confusion that might possibly arise from a study of both mosquitoes and tsetse-flies in one show-case, followed by an examination of mosquitoes and tsetse-flies in other cases. It is preferable to complete the examination of all the mosquitoes exhibited, and then to commence the study of the tsetse-flies, and to pass on subsequently to other groups of insects in their turn.

While most of the specimens are displayed in ordinary museum show-cases, a few, mainly fleas, are shown under two microscopes of special construction which permits of the examination of several specimens in succession. The slides are

attached to a drum, which rotates upon its axis by means of a milled wheel operated by the visitor. Another milled wheel at the side of the instrument enables the visitor to adjust the focus to suit his own eyesight. The microscope on the West side of the Hall carries twelve slides, that on the East five slides.

MOSQUITOES AND MALARIA.

Malaria is a disease of man caused by minute parasites that invade the red corpuscles of the blood. The parasites belong to a very low grade of animals, and are included in the division of the Protozoa known as Hæmosporidia.

Formerly malaria, commonly known in this country as ague, was thought to be contracted by breathing the air of marshy districts, but it is now proved that it is due to these parasites, transmitted from man to man by the bite of certain kinds of mosquitoes or gnats. Although there are many hundreds of species of mosquitoes, it is only those belonging to the genus *Anopheles*, and only certain species of that genus, that are capable of conveying malarial parasites to man. The parasite multiplies not only in the human blood, but also in the walls of the stomach of the mosquito.

Various forms of malaria are distinguished by medical men according to the frequency of the recurrence of fever and other symptoms, as tertian, quartan, etc. Each is due to a distinct species of parasite, though the visible differences between the species are very slight. The parasite of pernicious or aestivo-autumnal fever is known under the name of *Plasmodium falciparum* Welch (= *Laverania malariae* Grassi and Feletti); that of tertian fever is *Plasmodium vivax* Grassi and Feletti, and that of quartan fever, *Plasmodium malariae* Laveran. Parasites similar to these frequently occur in the blood of other mammals, more especially in that of apes and monkeys, and also in the blood of birds of many species.

Malaria is now almost extinct in Northern Europe, but in many parts of the tropics it is still one of the commonest of diseases. At the beginning of the present century, however, practical measures for the extermination of mosquitoes were introduced in many parts of the tropics, and the rigid enforcement

of these precautions has frequently been followed by marked diminution in the prevalence of malaria, or even its total or almost complete disappearance.

In a table-case that stands at the entrance to Bay X, near the statue of Prof. Huxley, are shown two greatly enlarged models ($\times$ 28) of one of the malaria-carrying species of mosquito, *Anopheles maculipennis* Mg., together with an actual specimen, for the purpose of giving a correct impression of the real size of the insect. The model on the left hand panel shows the attitude of the mosquito when flying (fig. 3, p. 15); that on the right hand panel shows its attitude when at rest (fig. 2, A). Both of the models represent the female insect, for in the species of mosquito that suck blood the blood-sucking habit is confined to the female. In the case of an infected mosquito capable of communicating the disease, the young forms of the malarial parasite escape into the blood with the secretion of the salivary glands, which is introduced into the wound at the time of the bite.

In the middle part of this case is shown a series of greatly enlarged models ($\times$ 6,000) illustrating the complete life-cycle of the parasite of pernicious or aestivo-autumnal malarial fever, *Plasmodium falciparum*, some stages of which are passed through in the blood of man, others in the body of the mosquito. The models are numbered consecutively, and are explained in the following terms:—

1.—A malarial germ or sporozoite (fig. 1, *a*), as introduced into the blood of man by the proboscis of a female anopheline mosquito.

2.—The sporozoite penetrates into a red blood-corpuscle, and becomes rounded off into a compact mass (fig. 1, *b*).

3.—The parasite enlarges and a vacuole appears within it. Signet ring stage.

4.—The vacuole disappears, and the parasite enlarges and emits blunt processes. Amoebula stage.

5.—The nucleus multiplies, and the pigment granules increase in number (fig. 1, *c*).

6.—The nuclei arrange themselves at the periphery. Rosette stage.

7.—The daughter-individuals (merozoites) separate from the central non-nucleate protoplasm (fig. 1, *d*).

8.—The merozoites become free in the blood-plasma by the disintegration of the red corpuscle (fig. 1, *e*). Each merozoite invades a red blood-corpuscle, and develops into amoebula, rosette, and further merozoites, as explained in the preceding models.

9, 10.—After several cycles of amoebula, rosette, and merozoites, a merozoite on entering a red corpuscle grows into a sexual form which may be crescentic (fig. 1, *f*).

11.—The crescent increases at the expense of the corpuscle, and male crescents become distinguishable from female crescents, as explained in models 12 and 15. The crescents undergo no further change in human blood, but when blood containing crescents is sucked by a female anopheline mosquito, the crescents undergo development.

12.—The male crescent (fig. 1, *g*) is shorter and more rounded than the female crescent. It has clearer protoplasm and a larger nucleus, and the pigment granules are more scattered.

13, 14.—The male crescent becomes spherical and the nucleus multiplies.

15.—The female crescent (fig. 1, *h*) has denser protoplasm and a smaller nucleus than the male, and the pigment granules are in the middle part of the crescent.

16, 17, 18.—The female crescent becomes spherical, and, after extruding two small cells (? polar bodies) in succession, becomes the macrogamete or ovum, and is ready for fertilisation.

19.—The male sphere shoots out four, five or six slender processes (microgametes or sperms) consisting mainly of nuclear material (fig. 1, *i*). The remainder of the sphere plays no further part in the life-history.

20.—A microgamete is attracted by, and enters into an ovum (fig. 1, *j*).

FIG. 1.—LIFE HISTORY OF THE ORGANISM OF PERNICIOUS MALARIA.

a, malarial germ or sporozoite, as introduced into the blood of man by a female anopheline mosquito at the time when it is sucking blood; *b*, sporozoite after entry into a blood-corpuscle of man; *c*, growth of the sporozoite into an amoebula; *d*, division of the amoebula to form merozoites; *e*, liberated merozoites; *f*, growth of a merozoite into a crescent; *g*, free male crescent; *h*, free female crescent; *i*, male cell with projections, which lengthen and are set free as sperms; *j*, fertilisation of an ovum by a sperm; *k*, fertilised egg as an active motile vermicule; *l*, sphere formed from the enlarged vermicule, after this has bored through the stomach-wall of the mosquito; *m*, portion of the sphere or cyst at a late stage of development, containing countless needle-shaped spores, which, when the cyst bursts, escape as sporozoites into the organs of the mosquito's body, and pass through the salivary glands into the proboscis, and so infect a man bitten (i.e. pricked) by the mosquito. *a–l* are enlarged 3,500 diameters; *m* is drawn to a smaller scale of magnification.

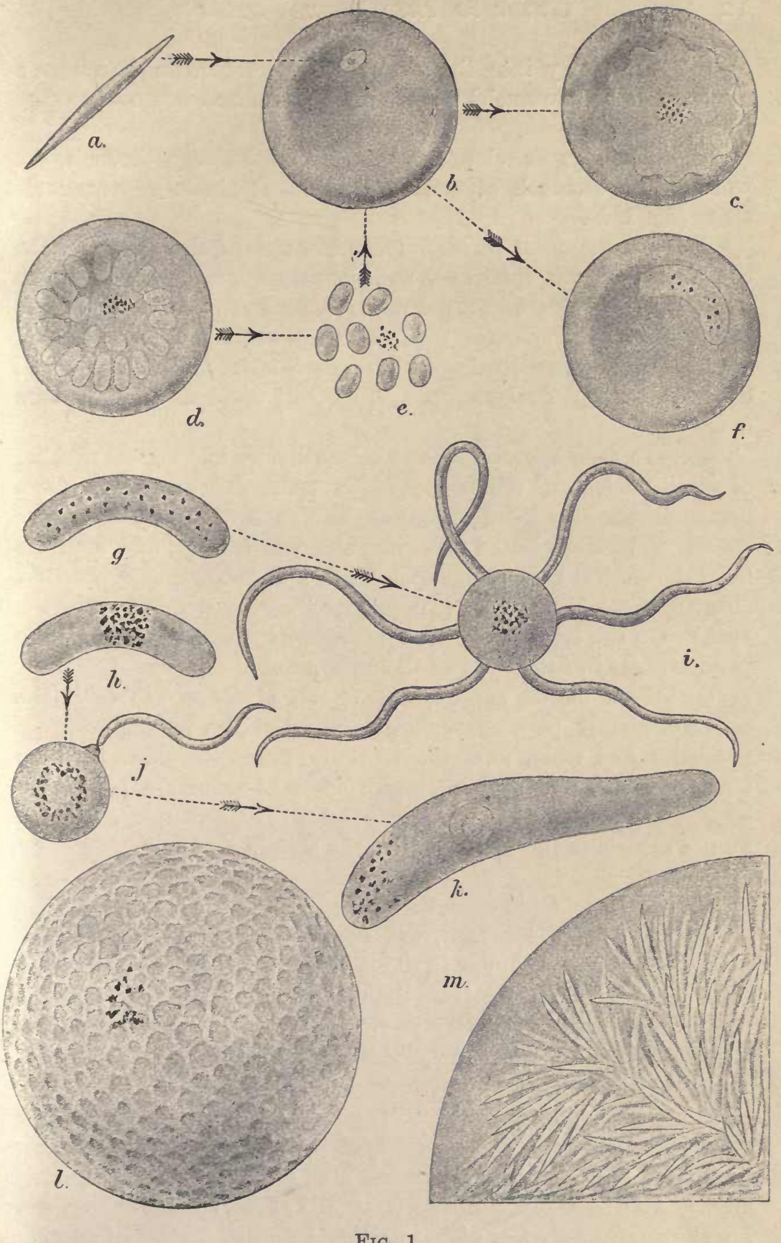

FIG. 1.

21.—On entry into the ovum the microgamete becomes a nucleus. The two nuclei unite, and the fertilised ovum or zygote becomes motile.

22.—The zygote elongates and bores its way through the wall of the stomach of the mosquito. Oökinete or vermicule stage (fig. 1, *k*).

23.—On the outer surface of the stomach of the mosquito the oökinete becomes spherical, and increases greatly in size, the nucleus multiplying at a rapid rate. A protective covering or cyst forms around the sphere. (Only one half of the sphere is shown.)

24.—The sphere divides up into sporoblasts, each being a small cell with a single nucleus (fig. 1, *l*). (Only one half of the sphere is shown.)

25.—In each sporoblast the nucleus divides into a great number of small nuclei, and the surface of the sporoblast grows out into a great number of pointed processes, into each of which a nucleus enters. These nucleated processes elongate further, and separate from the central part of the sporoblast, and become motile spores or sporozoites (fig. 1, *m*). (The model shows only one half of the cyst.) On the bursting of the cyst the sporozoites escape into the various organs of the body of the mosquito.

26.—Free motile sporozoites. Such of these as reach the salivary glands pass through the ducts of the glands into the proboscis, and when next the mosquito pricks the skin of a man for the purpose of sucking blood, some of them are left in his body, and develop in the red corpuscles in the manner explained by the models in the upper part of the series.

In the large table-case that stands in Bay VI, on the East side of the main staircase, are shown models of the malarial parasite somewhat similar to those just referred to, but of earlier construction. They illustrate the phases in the life-history of the organism so far as they were known at the time when the models were made (1901); the more recent series, in the case near Bay X, embodies the results of investigations up to May 1913.

On the sloping panels in this table-case in Bay VI are mounted enlarged models (× 28) of one of the malaria-carrying mosquitoes, *Anopheles maculipennis* Mg., similar to the two models already seen in the other case (Bay X). Side by side with these are shown, for purposes of comparison, enlarged models of another

gnat or mosquito, *Culex pipiens* Linn., an insect which, although it can make itself unpleasant, does not transmit malaria.

The models on the South side of the case represent the insects in the resting attitude, and illustrate a characteristic difference between anopheline and culicine mosquitoes. The former have the proboscis, thorax and abdomen set in a straight line, whereas culicine mosquitoes, when viewed from the side, have a hump-backed appearance, owing to an arching of the thorax, so that the line of the proboscis is set at an angle to the axis of the hinder part of the body. When resting on a wall or other flat surface, a

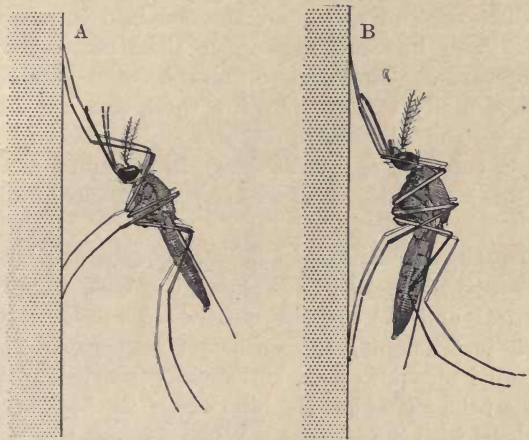

FIG. 2.—ANOPHELINE AND CULICINE MOSQUITOES IN RESTING ATTITUDE.
A. *Anopheles maculipennis*, female, × 4.
B. *Culex pipiens*, female, × 4.

culicine keeps the abdomen more or less parallel to the surface, whereas an anopheline slopes the abdomen away (fig. 2). Anophelines nearly always have spots on the wing. In both sexes of anopheline mosquitoes the maxillary palps are as long as the proboscis, and those of the male are clubbed at the tip. In culicines the palps of the female are much shorter than the proboscis, and those of the male are a little longer than the proboscis, and usually not clubbed at the tip—in mosquitoes the male can be readily distinguished from the female by the more plumose or fluffy antennae. In culicines the abdomen is completely clothed with scales like those on a moth's wing, some of the scales forming

in many species conspicuous white transverse bands at the base of each segment; in anophelines the abdomen is without distinct scales, and hence without well-defined markings.

In the lower part of the South side of the case are displayed a series of models, enlarged 28 diameters, like those of the adult insects, showing the appearance of the eggs, the larvae and the pupae of *Culex* and *Anopheles*. The black threads stretched horizontally represent the surface of the water. The eggs of mosquitoes float upon the surface, and the larvae and pupae move about in the water, breathing by means of their air-tubes, which now and again are caused to project very slightly above the surface. The eggs of *Culex* are massed into a raft composed of two or three hundred eggs with their more pointed ends directed upwards. The eggs of *Anopheles* float singly or in small groups easily scattered by the wind, and are disposed on their sides instead of standing erect upon the water. Each egg has a pair of small air spaces, as shown in the upper model (× 65) at the right hand end of the series, above the group of eggs (× 28).

The characteristic attitude of the larva of the culicine mosquito is one in which the head is downmost, the body slightly inclined to the vertical, and the extremity of the air tube at the hind end of the body just touching the surface of the water. The larva of the anopheline mosquito rests horizontally just below the surface of the water; the air-tube at the hind end of the body is very short, and just level with the surface. When feeding, the larva twists its head half-way round, and laps the surface of the water for minute vegetable organisms. Both culicine and anopheline larvae when alarmed strike down into the water with a rapid jerking movement.

The pupae of the culicine and anopheline mosquitoes do not differ greatly. In each case the pupa rests with the two horn-like air-tubes on the thorax at the surface of the water, but it can swim rapidly by a jerking movement of the abdomen, which is provided at its extremity with two transparent paddle-like organs.

In the lower part of the North side of the case are enlarged drawings of the mouth-parts of the two species of gnat or mosquito illustrated, the culicine, *Culex pipiens*, and the anopheline, *Anopheles maculipennis*. The proboscis of mosquitoes consists of a long, channelled labium and six piercing instruments contained

within it—a labrum, a hypopharynx, a pair of maxillae, and a pair of mandibles. The labrum of mosquitoes is generally long, slender, and pointed, and grooved beneath for the reception of the hypopharynx, which lies immediately below, and has its apex more or less wrapped round by the inflected margins of the labrum. The two maxillae are long, and each tapers gradually to the apex, which is provided with fine teeth. The two mandibles are of the same length as the maxillae, and their tips partially embrace the apices of the maxillae. All these

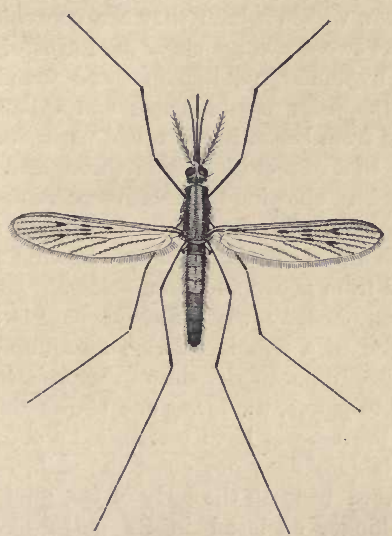

FIG. 3.—A MOSQUITO THAT SPREADS MALARIA, *Anopheles maculipennis*, female, × 4.

parts when at rest lie concealed in the labium, which is deeply channelled for their reception, and is furnished at its extremity with two fleshy lobes, the labella. The labium does not enter the skin of the animal attacked, but bends back beneath the body of the insect, the labella acting as guides to support the piercing organs.

In male gnats the mandibles are absent, and the maxillae are very short, and cannot be used as piercing instruments. The maxillary palps of the male *Culex* are as long as the proboscis,

and are somewhat brush-like, but in the female they are very short and simple.

In *Anopheles* the maxillary palps are long in both sexes. In the male the apical joint is thickened and hairy, and diverges from the proboscis, while in the female the palps are straight and lie close to the sides of the proboscis for their whole length.

The first three drawings exhibited show the head, as seen from above, of the female *Anopheles maculipennis*, and the female and male *Culex pipiens*. In order that the six piercing instruments may be clearly seen, they are represented as dislodged from the gutter-like labium, within which they are concealed in the living insect. The next two drawings show the forms of the extremities of the labrum, hypopharynx, maxillae and mandibles of female specimens of *Anopheles maculipennis* and *Culex pipiens*. The labrum is viewed from beneath, the other parts from above. The sixth drawing is that of a cross-section through the proboscis of a female *Culex pipiens*, showing the relative positions of the piercing organs when at rest; and the last is a diagram of the terminal portion of the labium of the same insect showing the form of the labella as viewed from above and from below.

On the sloping panel above the drawings are two diagrammatic models of the head of a female culicine mosquito or gnat, viewed from the side. The upper model shows the proboscis as it appears when beginning to pierce, the lower one shows the disposition of the parts when the lancets have penetrated a short distance into the skin. The labium does not enter the skin, but loops downward and backward beneath the body of the gnat, so that the six lancets are no longer enclosed in its gutter-like groove; the apposed labella continue to surround the lancets, and slide along them from point to base as the skin is penetrated.

For comparison with the culicine and anopheline mosquitoes there is shown, at the East end of the case, a model, enlarged 28 diameters like those of the mosquitoes, of a common midge, *Chironomus plumosus* Linn., a harmless insect, not to be mistaken for a mosquito or gnat. The model represents the female midge; the differences between the heads of the two sexes are illustrated in the two drawings above the model. An actual specimen of a male midge is also exhibited. *Chironomus plumosus* is one of the largest of the midges, and occurs in swarms in the air from April to August. The larger midges may be distinguished from

mosquitoes or gnats by the absence of the long proboscis, by the length of the front legs, and by their habit of resting with the front legs raised—in mosquitoes it is the hind legs that are raised when the insect is resting (see the models on the South side of the case).

In the lower part of this (East) end of the case is a model of the larva of *Chironomus plumosus*, a red, caterpillar-like, aquatic form sometimes termed a blood-worm. The larva lives in a tunnel which it makes at the bottom of some ditch, pool or rain-water butt. It breathes by means of four filaments, or blood-gills, at the hind end of the body, on the last segment but one, and four thicker processes on the last segment. Crawling movements are effected by a pair of foot-like organs beneath the head, and a pair at the hind end of the body. At night, and sometimes by day, the larva swims freely, jerking the body suddenly to the right and to the left in such a manner as to present the appearance of a figure of eight. When in its tunnel the larva imparts to its body an undulating movement, thus creating a flow of fresh water through the tunnel.

The series is completed by a model, enlarged 28 times linear like that of the larva and adult, of the pupa of the midge *Chironomus plumosus*. While still within its tunnel the larva turns into a pupa, and remains there, lying on its side and imparting an undulating movement to the body. The pupa breathes by means of a pair of tufted tracheal gills on the thorax. When approaching the stage of the imago or perfect insect, it leaves the tunnel and swims to the surface of the water; the skin splits along the back, and the winged midge emerges, and flies away almost immediately.

In the table-case that stands at the entrance to Bay I, near the bust of Sir William Flower, are shown dipterous insects of various kinds, tsetse-flies, tabanids and mosquitoes, selected because of their capacity for spreading diseases, and mounted together with examples of their near relatives, which, so far as our present knowledge goes, are harmless. Since almost all insects associated with maladies are of small size, the specimens are mounted close to the glass of the case, in order to enable visitors to see as much as possible of their general appearance and external characters. The mosquitoes of this series are on the West side of the case, away from the middle of the Hall. Examples are shown of both males and females, and the

geographical distribution of each of the species of which examples are shown is explained by means of a small map, with the regions in which the insect is found marked in red.

The following species of mosquitoes are exhibited, all known to convey the parasites of malaria from man to man, and thus to disseminate the disease:—*Anopheles maculipennis* Mg. (fig. 3, p. 15), *A. bifurcatus* Linn., Europe and North America—*A.* (*Myzomyia*) *listoni* Liston, *A.* (*M.*) *culicifacies* Giles, *A.* (*Myzorhynchus*) *barbirostris* v.d. Wulp, *A.* (*M.*) *sinensis* Wied., *A. Neocellia stephensi* Liston, *A.* (*N.*) *willmori* James, *A.* (*Nyssorhynchus*) *theobaldi* Giles, *A.* (*N.*) *fuliginosus* Giles, Asia—*A.* (*N.*) *maculipalpis* Giles, Asia and Africa—*A.* (*Myzomyia*) *funestus* Giles, *A.* (*Pyretophorus*) *costalis* Loew, *A.* (*Myzorhynchus*) *mauritianus* Grandpré, *A.* (*M.*) *paludis* Theob., *A.* (*Cellia*) *pharoensis* Theob., Africa—*A.* (*Nyssorhynchus*) *annulipes* Walker, Australia—*A.* (*Myzomyia*) *lutzi* Theob., *A.* (*Cellia*) *albimanus* Wied., *A.* (*C.*) *argyrotarsis* Rob.-Desv., South America.

Disregarding for the present the mosquitoes that spread yellow fever and filariasis, these being dealt with in this guide-book under subsequent headings, the visitor arrives at a selection of "apparently harmless" mosquitoes—those which do not, or at all events are not known to, disseminate disease, namely:—*Anopheles* (*Christya*) *implexus* Theob., *Megarhinus separatus* Arrib., *Toxorhynchites speciosus* Skuse, *Janthinosoma sayi* Dyar and Knab, *Stegomyia scutellaris* Walk., *S. apicoargentea* Theob., *Desvoidya obturbans* Walk., *Ochlerotatus cumminsi* Theob., *O. vittiger* Skuse, *Taeniorhynchus aurites* Theob., *Aedeomyia catasticta* Knab., *Theobaldia spathipalpis* Rond., *Culex concolor* Rob.-Desv., *C. annulirostris* Skuse, *C. tigripes* Grandpré, var. *fuscus* Theob., *Mimomyia plumosa* Theob., *Harpagomyia genurostris* Leic., *Eretmopodites chrysogaster* Graham, *Wyeomyia communis* Leic., *Sabethes cyaneus* Fabr.

MOSQUITOES AND YELLOW FEVER.

So far as is at present known, yellow fever is disseminated solely by the mosquito *Stegomyia fasciata* Fabr., sometimes called the tiger-mosquito (fig. 4). As in all other mosquitoes that suck blood, the blood-sucking habit is confined to the female. The virus of the disease is introduced into the blood by the proboscis

of the infected insect at the time of the bite. Yellow fever is primarily a disease of the West Indies and the East Coast of Mexico, but it has been spread by shipping to many other parts of the world.

The causal agent of yellow fever is not known with certainty, although the disease has been attributed to an extremely minute protozoon found in the blood. That it is a living organism and not a chemical substance is evident from the fact that some time (about three days) elapses between the bite of the mosquito and the onset of the febrile symptoms, and a mosquito is not capable

FIG. 4.—A MOSQUITO THAT SPREADS YELLOW FEVER,
Stegomyia fasciata, female, × 4.

of infecting until about twelve days after it has sucked the blood of a yellow-fever patient. These intervals of time are clearly periods during which an organism is undergoing some parts of its developmental process.

Specimens of *Stegomyia fasciata* Fabr. are shown in the series of mosquitoes on the West side of the table-case that stands at the entrance of Bay I. The species occurs in tropical and subtropical regions throughout the world, and is also found in Southern Europe and other countries bordering the Mediterranean Sea, and in the southern parts of the United States of America.

In a small case standing between the statue of Sir Richard Owen and the bust of Sir William Flower in Bay I is shown a model of the yellow-fever mosquito, *Stegomyia fasciata*, enlarged 28 diameters so as to be comparable with the enlarged models of *Culex pipiens* and *Anopheles maculipennis* shown elsewhere. On the back of the panel is a map showing the distribution of the species.

In general attitude a *Stegomyia* resembles a *Culex* rather than an *Anopheles* (fig. 2, p. 13); the thorax is arched, giving a hump-backed appearance to the body. The thorax of *Stegomyia fasciata* is black, with a conspicuous lyre-shaped wihte mark on the back; the tarsi are black, ringed with white at the base of each joint. In *Culex pipiens* the thorax is brown, without distinct markings, and the tarsi are black.

Essentially a domestic species, *Stegomyia fasciata* is always found in the vicinity of human habitations. Its wide distribution is believed to be largely due to the insect, in the egg, larval and adult stages, having been carried about the world in ships. It breeds not only in water-barrels and cisterns, wells, and the bilges of ships, but also frequently in puddles and pools of clean, foul, or brackish water, and even in a small quantity of rain-water standing in an old sardine-tin or broken bottle. The eggs are remarkably resistant, and are not necessarily rendered incapable of development if the water on which they are laid happens to dry up. In one instance some eggs of *Stegomyia* that had been kept in a dry state for six months gave rise to living larvae after being placed in water.

MOSQUITOES AND FILARIASIS.

Filariasis is a general term applied to diseases caused by thin thread-worms of the genus *Filaria*. Elephantiasis, one of these diseases, is due to *Filaria bancrofti* Cobbold, the embryos or larvae of which are carried from man to man by certain mosquitoes, particularly *Culex fatigans* Wied. Mosquitoes are also responsible for the spread of some other forms of filariasis, and it is interesting to note that some species of mosquito spread both malaria and filariasis.

In the table-case that stands at the entrance of Bay I are shown the following mosquitoes known to be instrumental in the spread of various forms of filariasis:—*Anopheles maculipennis* Mg. (fig. 3, p. 15), *A.* (*Myzorhynchus*) *sinensis* Wied, var. *nigerrimus*

Giles, and var. *minutus* Theob., *A.* (*Myzomyia*) *rossi* Giles, *A.* (*M.*) *funestus* Giles, *A.* (*Pyretophorus*) *costalis* Loew, *A.* (*Cellia*) *argyrotarsis* Rob.-Desv., *Culex fatigans* Wied., *Stegomyia pseudoscutellaris* Theob., *Mansonioides uniformis* Theob., *Taeniorhynchus titillans* Walk., *T. pseudotitillans* Theob.

FISHES THAT FEED UPON THE LARVAE OF MOSQUITOES.

By reducing the numbers of the larvae, and consequently the number of mosquitoes, certain fishes are beneficial in their effect, and lessen the chance of transmission to man of mosquito-borne diseases.

The five fishes exhibited in the glass vessel of alcohol are denoted by letters. A is the male, and B the female of a little fish known as "millions" (*Lebistes reticulatus* Peters). C is a female specimen of a "top-minnow" (*Gambusia affinis* Girard). D is a male, and E a female of *Haplochilus pumilus* Blgr., a fish without a popular name.

"Millions" (A and B) occur in fresh and brackish waters of Venezuela, Guiana, Trinidad, and the Windward Islands. The correct scientific name is *Lebistes reticulatus*, but the species has also been described as *Girardinus poeciloides* (from Barbados), as *Girardinus guppyi* (from Trinidad), and as *Poecilia reticulata* (from Venezuela). The females are viviparous; the males are smaller than the females, and have ornamental markings, whereas the females are plain in coloration. "Millions" are very prolific, producing a brood every few weeks. They have been exported into various tropical countries for the purpose of reducing the numbers of mosquitoes, but those recently introduced into Africa are said to have been devoured by the frogs.

"Top-minnows" (C) like "Millions," are viviparous, and belong to the Poeciliine group of the Cyprinodont fishes; they inhabit the Mississippi and fresh and brackish waters from Florida to Texas.

Haplochilus pumilus occurs in Lake Tanganyika and Lake Victoria in Central Africa; it is oviparous, and although it is known to devour mosquito-larvae but little has been recorded as to its natural history.

TSETSE-FLIES AND TRYPANOSOMIASIS.

Trypanosomiasis is a general term applied to diseases caused by species of Trypanosomes, small blood-parasites of an animal nature, belonging to the division of the Protozoa known as the Haemoflagellata.

Tsetse-flies are African, blood-sucking, dipterous insects, with peculiarly modified, piercing mouth-parts. The blood-sucking habit in tsetse-flies is common to both sexes, whereas in mosquitoes the females alone suck blood. The virus of the disease is introduced into the blood by the proboscis of the infected insect at the time of the bite.

In one of the cases in the middle part of the Hall, near the statue of Sir Richard Owen, is shown a large model (× 28) of one of the tsetse-flies, *Glossina morsitans* Westw., which is mainly responsible for the spread of a deadly disease—nagana—among domesticated animals. In the blood of African animals, such as antelopes and buffaloes, there is frequently found a parasite, *Trypanosoma brucei* Plimmer and Bradford, which apparently causes little inconvenience to the host, but this, if transferred to a horse, ox or dog by the piercing proboscis of a tsetse-fly that has previously fed upon the blood of an infected antelope, gives rise to the nagana or tsetse-fly disease. The fatal disease of man known as sleeping sickness is spread by the tsetse-flies *Glossina palpalis* Rob.-Desv. (fig. 6, p. 25) and *G. morsitans* Westw. The organisms causing sleeping sickness are *Trypanosoma gambiense* Dutton (fig. 5) and *T. rhodesiense* Stephens and Fantham, in West and Central Africa and North-east Rhodesia respectively.

In the same case are shown actual specimens of the tsetse-flies *Glossina morsitans* and *G. palpalis*, and enlarged coloured drawings (× 2) of the under and side views of a specimen of the former species, showing the collapsed and the gorged condition of the abdomen before and after a meal of blood. Another drawing, of the natural size, shows how the wings of a tsetse-fly overlap one another above the abdomen when the insect is at rest. In the glass vessel are four larvae at different stages of growth, and a pupa, of *Glossina palpalis*. The end of the pupa-case that bears the two projections is the hind end, as is explained in the enlarged drawing (× 12) placed alongside.

Sketches are exhibited of a horse and a dog suffering from

nagana or tsetse-fly disease. In the horse the onset of an attack may be detected by the coat staring, and by a watery discharge from the eyes and nose. Shortly afterwards there appears a general swelling of the belly and hind extremities, which fluctuates from day to day. The animal hangs its head, and there is a general emaciation, sometimes accompanied by blindness. Death results from exhaustion; there are no symptoms of pain, and the appetite continues good till the last. In the dog the disease runs a rapid course, and is invariably fatal. The chief symptoms are extreme emaciation, swelling of the extremities, eruption over the body with the formation of blebs and pustules containing more or less purulent matter, and finally milky opacity of the cornea giving rise to blindness.

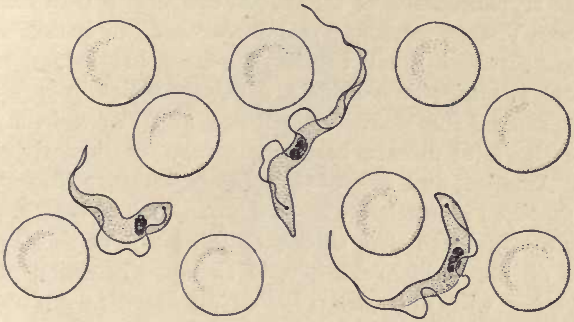

FIG. 5.—ORGANISMS OF SLEEPING SICKNESS,
***Trypanosoma gambiense*, and red blood-corpuscles; × 1,500.**

A map of Central and Southern Africa is exhibited, showing our knowledge of the distribution of the tsetse-flies (*Glossina*) in 1911, at the time of the issue of Mr. E. E. Austen's "Handbook of the Tsetse-Flies," published by the Trustees of the Museum.

Around the lower part of the case are shown enlarged coloured illustrations (× 6) of the ten species of tsetse-flies that were known at the time of the publication of the book in 1911.

Displayed upon the glass shelf in the case are greatly enlarged transparent models (× 6,000) of red blood-corpuscles and a form of trypanosome (*T. lewisi* Kent) found commonly in the blood of rats. Trypanosomes are small, elongated, parasitic animals occurring in the fluid part (plasma) of the blood; they have an undulating membrane or longitudinal fin which runs along the

body, and is continued forwards into a filament or flagellum. In an allied genus, *Trypanoplasma*, there is a flagellum at each end of the body.

Although many forms of trypanosomes are spread from one vertebrate host to another by tsetse-flies, some are spread by other blood-sucking invertebrates, such as gnats, fleas, leeches, etc.; the trypanosomes that are found in skates and similar fishes, for instance, are known to be conveyed by marine leeches. In the case is shown a specimen of an African fly, *Hippobosca rufipes* von Olfers, allied to the forest-fly of Britain, *Hippobosca equina* Linn. (see enlarged photograph (× 6) below the glass plate), and responsible for the spread of the blood-parasite *Trypanosoma theileri* Bruce, causing gall-sickness among cattle in the Transvaal.

Other trypanosomes of interest in connection with disease are *T. equinum* Vosges, causing "mal de caderas" of horses in South America, *T. evansi* Steel, causing surra of horses and cattle in India, and *T. equiperdum* Doflein, causing dourine in horses in the countries around the Mediterranean Sea, and *T. cruzi* Chagas, the cause of the fatal disease barbeiro in man, particularly children, in South America, and conveyed by a hemipterous insect or bug, *Lamus megistus* Burmeister, more than an inch in length.

In the large case that stands at the entrance to Bay I, near the bust of Sir William Flower, is shown a selection of tsetse-flies, together with enlarged coloured drawings (× 6), and maps showing the distribution of the several species. Tsetse-flies may be said to be African insects, although one species is met with in south-western Arabia, and in former times tsetse-flies existed in North America.

The first examples shown are those of *Glossina palpalis* Rob.-Desv. (fig. 6) of West and Central Africa, the principal disseminator of *Trypanosoma gambiense* Dutton, causing sleeping sickness in man. These tsetse-flies exist only in shady places, and haunt the margins of lakes and water-courses where the banks are covered with vegetation. Specimens are shown of young and full-grown larvae (in the small glass vessel of alcohol), and of pupae, together with some of the soil in which they were found (in the glass-topped box). *Glossina palpalis*, like other tsetse-flies, but unlike the vast majority of flies in general, does not lay eggs; the female produces at intervals a single larva, or maggot, which is retained within the body of the mother until full

grown. The maggot of *G. palpalis* is dropped by the mother in a shady place near water, where the soil is loose or sandy, moderately dry, and often consisting of crumbling vegetation. On being deposited, the maggot buries itself in the loose earth; its skin then becomes dark in colour, contracts, and hardens into a barrel-shaped puparium or case, within which the change to the pupa or chrysalis takes place. A female fly of this species may produce from eight to ten larvae altogether, one at a time at intervals of nine or ten days.

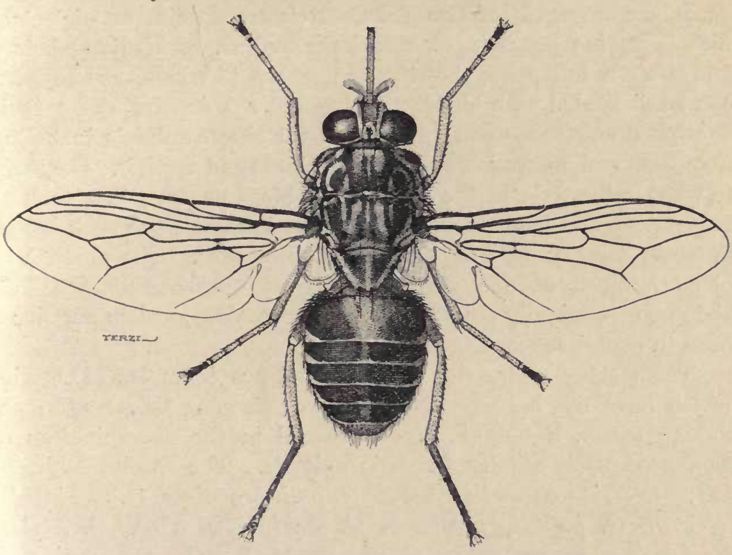

FIG. 6.—A TSETSE-FLY THAT SPREADS SLEEPING SICKNESS, *Glossina palpalis*, female, × 5.

Specimens of *Glossina palpalis* are shown in the attitude in which they rest. A resting tsetse-fly can be distinguished from any other blood-sucking fly with which it could possibly be confused by the fact that the wings, instead of diverging at the tips, lie closed flat over one another down the back like the blades of a pair of scissors, while the proboscis with which the bite is inflicted projects horizontally in front of the head.

Glossina morsitans Westw. is a widely distributed tsetse-fly (see map), spreading nagana among domestic animals, and i Nyasaland and Northern Rhodesia conveying to man th

form of sleeping sickness caused by *Trypanosoma rhodesiense* Stephens and Fantham. This species of tsetse-fly is usually confined to definite tracts of country, known as "fly-belts," often of very limited extent. Unlike *G. palpalis*, *G. morsitans* is not confined to the immediate vicinity of water. The female deposits its maggot or larva in hollows about the roots of trees, and not in the soil under bushes, where it might be found by the scratching of guinea-fowl and other birds in search of food. Some empty pupa-cases are shown.

In the larger of the two glass vessels are specimens of tsetse-flies (*Glossina palpalis*, *G. morsitans* and *G. tachinoides*) before and after a full meal, showing the extent to which the abdomen can be distended with blood. Tsetse-flies are dependent for their continued existence upon the blood of vertebrate animals, including man, wild and domesticated mammals, birds and reptiles. Contrary to what is the case in the majority of blood-sucking flies, such as mosquitoes and horse-flies, in which the females alone suck blood, in tsetse-flies the habit is common to both sexes. The amount of blood imbibed at one meal is relatively considerable, the fly's abdomen—originally empty and flat—becoming swollen out like a bead in consequence.

The tsetse-flies on the second panel are examples of species which have not been proved to convey sleeping sickness to man, though many, if not all, are concerned in the dissemination of trypanosomiasis among domestic animals. The species exhibited are:—*Glossina caliginea* Austen, *G. pallicera* Bigot, *G. tachinoides* Westw., *G. pallidipes* Austen, *G. longipalpis* Wied., *G. austeni* Newst., *G. fusca* Walk., *G. nigrofusca* Newst., *G. brevipalpis* Newst., *G. medicorum* Austen, and *G. longipennis* Corti.

TABANID FLIES AND "CALABAR SWELLINGS."

The disease known as "Calabar swellings," a form of filariasis prevalent in West Africa, is caused by thin thread-worms of the species *Filaria* (*Loa*) *loa* Stiles, the larva of which undergoes its metamorphosis in the salivary glands of female tabanid flies of the genus *Chrysops*.

Tabanid flies are large flies, sometimes termed horse-flies or mangrove-flies, widely represented in tropical, subtropical and temperate parts of the world. Only the females suck blood. The larvae of the flies are carnivorous, and live in water, wet sand or mud, earth or decaying vegetable matter.

In the table-case that stands at the entrance to Bay I are shown examples of *Chrysops dimidiata* v. d. Wulp and *Chrysops silacea* Austen, both of which are known to be instrumental in the spread of the disease. Both species occur in West Africa, the former ranging from Portuguese West Africa to Ashanti, the latter through Southern and Northern Nigeria and the Belgian Congo.

For comparison with the two foregoing species are shown some tabanid flies that do not, or, at all events, are not definitely known to disseminate disease, although certain of them are suspected of spreading forms of trypanosomiasis among domestic animals. In many parts of tropical Africa tabanid flies are abundant at certain seasons, when owing to the bloodthirstiness and pertinacity of the females, the insects become an intolerable pest, both to man and to stock. The exhibited specimens belong mainly to the genera *Chrysops*, *Silvius*, *Pangonia*, *Tabanus*, *Haematopota* and *Hippocentrum*, and in each case the range of the species and any features of interest in their natural history are mentioned.

HOUSE-FLIES AND INTESTINAL DISEASES.

Many of the diseases broadly termed filth diseases are spread by house-flies; some of them are skin-diseases, others are diseases of the alimentary canal, such as enteric or typhoid fever, cholera, dysentery and infantile summer diarrhoea. House-flies are something more than disagreeable companions and pertinacious nuisances of the hot weather; they are dangerous by reason of their habit of settling upon food and contaminating it with such disease germs as they may happen to be carrying. In America the common house-fly has been termed the typhoid-fly, an unfortunate expression implying that typhoid fever is the principal, if not the only, disease that

is spread by the insect; in large towns, where the arrangements for the disposal of sewage are good, the greatest harm done by the house-fly is in the dissemination of infantile summer diarrhoea, with a large death rate. In camps and other places away from towns, where it is difficult to secure adequate disposal of human excreta, the danger of the spread of gastro-intestinal diseases by flies becomes very considerable. The organisms causing these diseases are mostly of a bacterial nature; enteric or typhoid fever is due to a motile bacillus (*Bacillus typhosus* Eberth-Gaffky), which in certain conditions exhibits from eight to twelve delicate threads or cilia projecting from the body (fig. 7).

In a table-case that stands on the East side of the Hall, between the statue of Sir Richard Owen and that of Prof. Huxley, are models of the common house-fly, *Musca domestica* Linn., adult female (fig. 8), and a group of eggs, a larva and a pupa, all

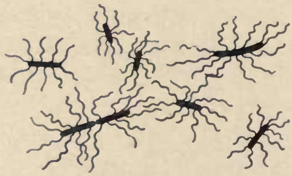

FIG. 7.—ORGANISMS OF TYPHOID FEVER, *Bacillus typhosus*; × 1,500.

enlarged 28 diameters. Actual specimens are also shown of the common house-fly and of three other species of house-fly, the most abundant of which in houses is the lesser house-fly, *Fannia canicularis* Linn.

The lesser house-fly is smaller than *Musca domestica*, and is often taken by the ignorant to be a common house-fly that has not yet grown up. As a matter of fact, a fly that has once emerged from its pupa-case does not increase in size. Occasionally small specimens of *Musca domestica* are met with, but these are undersized flies whose small dimensions are due to insufficiency or excessive dryness of food during the larval or maggot stage. The lesser house-fly differs in its habits from the common house-fly, and rarely associates with the latter. While the common house-fly is found largely in the kitchen and dining-room, and settles indiscriminately on the wall, the table, exposed food, and

one's hands and face, the lesser house-fly remains mostly on the wing, flying about with a curious darting movement beneath the gas-bracket or electrolier in the middle of the bedroom. The lesser house-fly appears earlier in the year than the common house-fly, and persists later, being still found in dwelling rooms as late as November. The lesser house-fly is closely related to the latrine-fly or privy-fly, *Fannia scalaris* Fabr., but the latter, although a dangerous disseminator of intestinal disease in villages and camps, is scarcely a house-fly; it rarely enters houses.

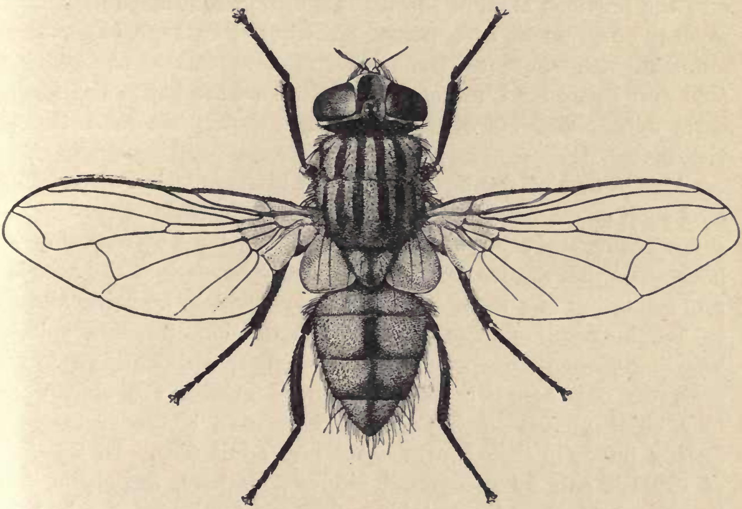

FIG. 8.—COMMON HOUSE-FLY,

Musca domestica, female, × 6; largely responsible for the spread of typhoid fever and summer diarrhoea.

Shown in the same case are specimens of two other house-flies, *Muscina stabulans* Fln., a large fly, not frequent in its occurrence, and *Stomoxys calcitrans* Linn., commonly termed the stable-fly. This last is a biting, blood-sucking fly, common in the country and in suburbs, and met with sometimes in the middle of large towns. People who do not discriminate between the different kinds of house-fly imagine, when bitten by a *Stomoxys*, that it is an ordinary house-fly that has become particularly vicious. Critical examination

of the insect shows that it has a straight piercing proboscis projecting forwards from the head.

The common house-fly is incapable of biting; its proboscis is large and soft, and is situated on the under side of the head, and contains numerous minute tubes through which fluid nutriment is sucked. A fly cannot take in solid food; if the food is dry, as for instance a piece of sugar, the fly moistens it by ejecting salivary fluid or by regurgitating the fluid contents of its storage-stomach or crop. It is in this way, among others, that the fly infects food with disease organisms, for flies are indiscriminate in their habits, and the previous meal of the fly in question may have been made upon the excrement of a person suffering from typhoid, or of an infant ill with summer diarrhoea. The mere walking of a fly upon food may infect it with microbes, for the feet are hairy, and readily carry minute droplets of substance that the fly has recently been visiting.

At one end of the case is shown a representation of a tray of food such as might serve for a light lunch—a plate of ham, a roll, a few plums and a jug of milk—looking repellent by reason of the house-flies that swarm upon it. At the other end of the case is a representation of a heap of kitchen refuse which, by being allowed to accumulate for some time in the dustbin, forms a suitable breeding-ground for house-flies; for flies, although an indoor pest, do not breed indoors. In this exhibit are shown the four chief phases in the life-history—eggs, larvae or maggots, resting pupae in their brown coats, and adult flies. In the heap of rubbish can be recognised cinders, feathers, egg-shells, fish-bones, mouldy bread, vegetable refuse and tea leaves, the last two being particularly harmful because, by keeping the whole mass damp and in a state of fermentation, flies are attracted to lay their eggs in it, their instinct prompting them to deposit the eggs where the maggots, on hatching out, will find themselves in surroundings most suitable for their development. Flies breed also largely in heaps of stable manure, and any decaying and fermenting vegetable refuse in the fields.

Just as the mosquitoes that carry malaria and yellow fever can be kept in check by attacking their breeding haunts, by preventing accumulations of rain-water, by draining marshes and by spraying with paraffin oil tracts of stagnant water, so as to prevent the development of eggs and larvae that would grow into mosquitoes,

so in the case of house-flies, it is more practicable to attack the next generation than the present generation, that is to say, to prevent the development of the larvae rather than to attempt to destroy the winged flies, and this can be done by taking measures such that moist rubbish and stable manure are not allowed to accumulate and serve as breeding places for the flies.

A single female of the common house-fly lays from 120 to 150 eggs at a time, and may deposit five or six batches during its life; and since in very hot weather the entire life-cycle may be completed in about three weeks, it is easy to account for the enormous swarms of flies sometimes seen.

The attention of visitors is drawn to a pamphlet entitled "The House-Fly as a Danger to Health," which can be purchased in the Museum for a penny.

Blow-flies are not included in the series exhibited, for although they are flies that enter houses and settle on food, particularly cold meat and fish, they are not dangerous in the same sense as the common house-fly. They are not attracted to dung-heaps and other exposed faecal matter, and they breed in flesh, such as the carcase of a recently dead animal. Blow-flies are a nuisance principally from their habit of laying their eggs in any cold joint of meat to which they have access. The eggs soon develop into maggots or gentles, and owing to the power which these larvae have of liquifying the meat around them, the joint becomes putrid much more rapidly than if it had not become "fly-blown."

SHEEP BOT-FLY.

In one of the two sloping-faced table-cases in the middle of the floor of the Hall are shown a specimen of the bot-fly of the sheep, *Oestrus ovis* Linn., three larvae, and enlarged coloured drawings ($\times$ 6) of the larva, pupa and adult female. The larvae or maggots of this fly live parasitically in the cavities in the front part of the head of the sheep, and when about to become pupae, escape from the nostrils and fall to the ground. After a time the winged flies escape, and lay their eggs in the nostrils of sheep.

In Algeria, especially in districts in which sheep are few and the human population fairly dense, the sheep bot-fly attacks the

Kabyl shepherds, laying its eggs, while flying, in the eyes, nostrils and lips; the larvae, when hatched, cause intense irritation of the conjunctiva, and of the cavities and sinuses of the nose and throat. The disease lasts about twelve days, and is known locally as thim'ni.

FLEAS AND PLAGUE.

Plague or bubonic pest is a disease of the rat, communicated from infected to healthy rats by fleas, of which *Xenopsylla cheopis* Rothsch. is the most important in tropical and subtropical countries. On the death of an infected rat the fleas leave the body, and if other rats are not available, will fasten upon man, and may communicate the disease. In man bubonic plague proves fatal in a large percentage of cases, and a marked feature of the disease is the enlargement of the superficial glands, such as those of the groin and armpit, into painful swellings or buboes.

Another type of plague, known as pneumonic plague, affects the lungs. The Manchurian epidemic of 1911 was of this type. The infection in this case appears to have originated from plague among the Mongolian marmots or tarbagans, *Marmota bobac* Pallas, that are trapped by the Manchurian hunters for the sake of their fur. The flea found upon the tarbagan is *Ceratophyllus silantiewi* Wagn.

In one of the table-cases in the middle of the floor of the Hall there are shown selected specimens and enlarged models of the tropical rat-flea, *Xenopsylla cheopis* Rothsch. (fig. 9), which, as stated above, is most responsible for the spread of plague in hot countries. The tropical rat-flea is found on several other mammals besides the rat; the hosts are mostly rodents, but include a few shrews. This species of flea has been spread by rats to such an extent that it is now found all over the world; it does not flourish, however, in cold climates.

The model on the pedestal is that of a male, enlarged 200 diameters. The names of the parts of the insect, so far as external features are concerned, are given in the coloured drawing below. At the ends of the case are shown enlarged models of the head and the hind end of a female tropical rat-flea ($\times$ 250), so arranged

that they may be readily compared with the corresponding parts of the male.

Models are also shown of the egg and larva of the tropical rat-flea, enlarged 150 diameters. The eggs of fleas are ellipsoidal in shape, similar at the two ends, and of a translucent appearance, suggesting thin china. The eggs laid by the rat-flea fall out of the fur of the host, and remain on the ground, usually within the

FIG. 9.—TROPICAL RAT-FLEA,

Xenopsylla cheopis, male, × 36; largely responsible for the spread of plague.

nest, run or burrow of the rat, until in about a week they hatch out into active, maggot-like larvae.

The larvae of fleas are not parasitic; they live on the ground either in the nest or the run of the host, and feed on all kinds of refuse that may occur there, their mouth-parts being adapted for chewing, and unlike those of the adult. They have no eyes, and no legs, but move about by means of the hairs or bristles projecting from the body, and the pair of processes or "struts" at the hind end. After spinning cocoons and passing through a pupal or

resting phase, they become slowly transformed into fleas, which finally emerge from their cocoons, and invade the fur of new hosts.

On the small glass table in the case are shown transparent models of human red blood-corpuscles and plague bacilli, enlarged 6,000 diameters (fig. 10). Bubonic plague, the disease that is transmitted by the bite of various kinds of flea, of which *Xenopsylla cheopis* is the most important in tropical regions, so that it is sometimes termed the plague-flea, is due to the presence of minute bacterial organisms, known as *Bacillus pestis* Kit., occurring in the blood. These organisms were first discovered during the epidemic of plague in Hong Kong in 1894. The bacilli occur in the fluid part (plasma) of the blood, and not in the

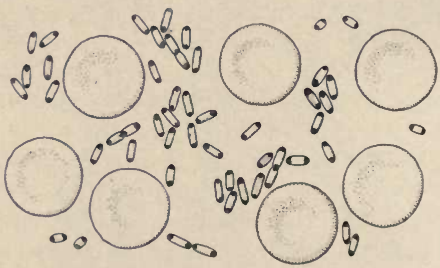

FIG. 10.—ORGANISMS OF PLAGUE,

Bacillus pestis, and red blood-corpuscles; × 1,500.

corpuscles; they may have the form of small rods with rounded ends, and sometimes show a constriction across the middle. Occasionally they are found in chains or series set end to end; each bacillus repeatedly elongates and divides across, thus increasing the total number at a rapid rate.

On the floor of the case are shown actual specimens of the tropical rat-flea and its larva, mounted on slips of glass. The specimens are so small that no details can be seen; they are introduced into the series merely to give a correct impression of the real size.

Under the microscope that is set upon the table at the entrance to Bay X on the East side of the Hall, near the statue of Prof. Huxley, are shown specimens of the tropical rat-flea, *Xenopsylla cheopis*, in five stages of its life-history. Slide A shows

the eggs; the thinness of the translucent shell is seen in the two broken eggs. Slide B shows the larva, stained red with carmine solution; the head end is to the left. The body of the larva is seen to be sparsely covered with stiff hairs or bristles, and there are no eyes nor legs. Slide C shows an early pupa, shrinking in length while still within the hairy larval skin. The first traces of the legs can be seen. Slide D shows a later pupa, very transparent and delicate in texture, owing to a reconstruction of all the internal parts of the body which takes place at this period of development. The legs are of considerable length, and the body is assuming the size and shape of the flea. Slide E shows an adult male; the body is now yellow, with an external hard casing of chitin, produced into numerous hairs and spines.

Returning to the middle of the Hall, the visitor will see in one of the two sloping-faced table-cases an enlarged, coloured drawing ($\times$ 40) of a female specimen of the human flea, *Pulex irritans* Linn. The flea of man is larger and darker in colour than the tropical rat-flea (*Xenopsylla cheopis*), and has larger stigmata or breathing pores, larger claws on the feet, and much larger eyes; the piercing mouth-parts, also, are stronger and broader. The long bristle which in the rat-flea passes backwards across or near the eye is much lower down in the flea of man; and in the latter there is no internal bar extending from the mid-coxa into the thorax—this last feature can only be seen in specimens that have been made transparent so as to render the internal structures visible. Other differences between the species occur in the sexual organs.

Under the microscope placed on the West side of the Hall near the entrance to Bay I. are shown twelve slides, of which nine are preparations of adult fleas of general interest.

A is a male tropical rat-flea, *Xenopsylla cheopis* Rothsch. (fig. 9). As already explained, this flea is common on rats (and other rodents) in warm countries, having become almost cosmopolitan in distribution. It is known to transmit the bacillus of bubonic plague from infected rats to man, and is frequently termed the plague-flea.

B is a male flea of the species *Ctenophthalmus agyrtes* Heller. This species of flea is common on rats, and also on field-mice, stoats and weasels, in Europe. It is not known to transmit any disease. It is distinguished from "A" by having no eyes, and by

having three spines on the lower edge (gena) of the head. There is also a comb of spines projecting back from the pronotum or first division of the thorax.

C is a male *Leptopsylla musculi* Duges, the common flea of the mouse, but also found on the rat. Though primarily European, it is now almost cosmopolitan. It has a comb of spines on the pronotum, but no eyes, and is distinguishable from "B" by having four genal spines instead of three.

D is a male *Ceratophyllus fasciatus* Bosc., a common rat-flea, almost cosmopolitan in distribution. It has eyes, and a comb of spines on the pronotum, but no genal spines.

E is a male *Ceratophyllus silantiewi* Wagn., the flea found on the Mongolian marmot, *Marmota bobac* Pallas, and responsible for the spread of pneumonic plague. It is with difficulty distinguishable from the common rat-flea (D).

F is a female cat-flea, *Ctenocephalus felis* Bouché, found not only on cats, but also on wild species of felidae, and on dogs. It is widely distributed, and is distinguished by having eyes, a comb of spines on the pronotum, and a row of eight spines (genal spines) at the lower edge of the head.

G is a female dog-flea, *Ctenocephalus canis* Curtis, found on cats as well as dogs. The flea resembles *Ctenocephalus felis*, but has the head more rounded.

H is a male human flea, *Pulex irritans* Linn. This flea is short and thick-set, with eyes, but no comb of spines on the pronotum. It is almost cosmopolitan in distribution.

J is a young female jigger flea, *Dermatophilus penetrans* Linn. The female jigger flea burrows into the human skin, and its abdomen becomes so enormously distended with eggs as to attain the size of a small pea. The part of the skin affected may become ulcerated and infected with various pathogenic bacteria, and so lead to serious consequences. Although a native of Mexico, Brazil and Argentina, the jigger flea is now spread also over most parts of tropical Africa, and has even reached India. It attacks other mammals besides man.

The slides K, L and M are preparations of a louse and two bugs, and will be referred to under their respective headings.

BED-BUGS AND DISEASE.

In one of the two sloping-faced table-cases in the middle of the floor of the Hall is a specimen and an enlarged, coloured drawing (× 20) of a female bed-bug, *Cimex* or *Clinocoris lectularius* Linn.; and under the microscope at the entrance to Bay I are shown specimens (slides L and M) of this species and the bed-bug of tropical Africa and the Oriental Region, *Clinocoris rotundatus* Sign.

Clinocoris lectularius (fig. 11), although commonly termed the European bed-bug, is a parasite which by the facilities for travel

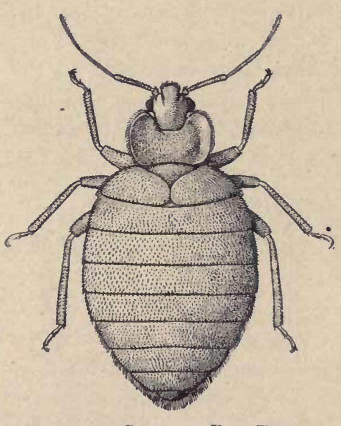

FIG. 11.—COMMON BED-BUG,
Clinocoris lectularius, male, × 10.

now possible has been spread all over the temperate and tropical parts of the world. It differs from *C. rotundatus* by its relatively broader abdomen; the prothorax also is broader, and the lateral lobes project more forward, and almost reach the eyes. The form of the mouth-parts of a bed-bug are seen in slide L. The labium has the form of a segmented proboscis; the four bristles seen projecting from the front of the head are the two maxillae and two mandibles, which in the living insect lie within a groove in the labium.

The common bed-bug has been suspected of carrying the virus of various diseases, such as leprosy, typhus and relapsing fever,

from infected to healthy persons, and *Clinocoris rotundatus* is known to be the carrier of a piroplasma parasite, *Leishmania donovani* Laveran and Mesnil, the cause of the tropical disease kala-azar, common in India.

LICE AND DISEASE.

Apart from the irritation which they cause, in some cases so great as to lead to loss of sleep and nervous prostration, lice are noxious insects because of their capacity for spreading typhus fever and some forms of relapsing fever (those of Europe and North Africa); lice have also been suspected as the infective agent in certain cases of leprosy, tuberculosis and plague. The organism of typhus fever has so far not been identified. That the causal organism undergoes some part of its development in the louse is evident from the fact that lice are especially infective from the fifth to the seventh day after feeding upon a person suffering from typhus fever. The organisms of the relapsing fevers are spirochaetes, blood parasites of spirally twisted, thread-like form.

Lice feed entirely upon blood, which they suck through punctures made in the skin ; they soon die when removed from the body, and differ in this respect from fleas and bugs. Three species of louse occur on man—the clothes-louse or body-louse, *Pediculus humanus* Linn. (fig. 12), the head-louse, *Pediculus capitis* de Geer, and the crab-louse, *Phthirus pubis* Linn. These are also found occasionally upon cats, dogs and monkeys living in association with man. Various kinds of mammals, from elephants to shrew-mice, have their own particular species of lice.

In one of the two sloping-faced cases in the middle of the Hall are shown some specimens and enlarged coloured drawings ($\times$ 50) of the clothes-louse and head-louse. In the same case a series of five lenses is arranged over mounted specimens of a head-louse, some pieces of human hair with nits or eggs of the louse, a clothes-louse, a crab-louse, and a louse (*Pediculus schäffi* Fahr.) from a chimpanzee. Under the microscope near the bust of Sir William Flower, on the West side of the Hall, is shown a mounted specimen (slide K) of the clothes-louse.

The clothes-louse is larger than the head-louse, and the sides of the abdomen are less deeply cleft between the segments. The antennae are slightly thinner in the clothes-louse than in the head-louse, and the front border of the thorax is less rounded. Other differences occur in the female sexual organs. In the crab-louse the body is shorter than in the two former species, and the thorax is broader than the abdomen; along each side of the abdomen are projections which at their tips carry pencils of

FIG. 12.—CLOTHES-LOUSE OR BODY-LOUSE,

Pediculus humanus, female, × 18; largely responsible for the spread of typhus fever.

hairs. In the louse of the chimpanzee the lateral margins of the abdomen are straight in front, but behind they present the appearance of a saw.

A female louse lays four or five eggs a day for about a month, and then dies. There is no caterpillar or maggot stage; the young, on hatching out, differ from the adults only in their smaller size and in certain trifling differences of structure. As they grow they moult the skin three times before arriving at the adult

condition, which is reached in about twelve days from the time of the hatching of the egg.

Lice are commonest in the poorer districts of a town, and spread rapidly among the children in a school. In times of war lice are apt to become particularly troublesome owing to their rapid increase in numbers, and the ease with which they can spread in the crowded life of a camp; the men have usually but few opportunities for effecting a complete change of garments and otherwise cleansing themselves, and so the conditions are favourable for a continuance of the infestation.

The attention of visitors is directed to a pamphlet entitled "The Louse and its Relation to Disease," which can be purchased in the Museum for a penny.

TICKS AND DISEASE.

The transmission of several diseases caused by blood-parasites, known as spirochaetes, may be traced to the bite of ticks, *e.g.*, human tick-fever or relapsing fever of tropical Africa, due to *Spirochaeta duttoni* Novy and Knapp (fig. 13), conveyed from one person to another by the tick *Ornithodoros moubata* Murray (fig. 14); and spirochaetosis in fowls and cattle, the fowl-tick being *Argas persicus* Oken. A typhus-like disease in man, known as Rocky Mountain spotted fever, is spread by the tick *Dermacentor venustus* Banks, and a recently observed obscure affection known as tick-paralysis in man, sheep and dogs, has also been shown to be due to the effects of tick-bites. Concerning the blood-parasite of heartwater of sheep, etc., conveyed by the bont tick, *Amblyomma hebraeum* Koch, in South and Central Africa, but little is known. A somewhat similar disease, the East Coast fever of cattle, is due to *Theileria*, a blood-parasite which occurs within the red blood-corpuscles of the host, like the forms of *Piroplasma* (*Babesia* and *Nuttallia*), which cause redwater or Texas fever of cattle in many of the warmer parts of the world, malignant jaundice of dogs in India and South Africa, biliary fever of horses in Africa and India, and carçeag of sheep in Southern Europe, all transmitted by ticks of the genera *Rhipicephalus*, *Margaropus*, and their allies.

In one of the two sloping-faced cases in the middle of the Hall,

between the main staircase and the statue of Sir Richard Owen, there is shown, on the North side, a series of ticks arranged in three groups. The first group consists of ticks that convey disease to human beings, and includes *Ornithodoros moubata* Murray, *Ornithodoros savignyi* Aud. and *Dermacentor venustus* Banks.

Ornithodoros moubata (fig. 14) is very widely distributed in Africa, and the regions where it is known to occur are marked in red in the map that is placed by the side of the specimens. This tick, which sometimes attacks domestic animals as well as human beings, transmits the blood-parasite *Spirochaeta duttoni* Novy and Knapp, the cause of the human relapsing fever of tropical Africa.

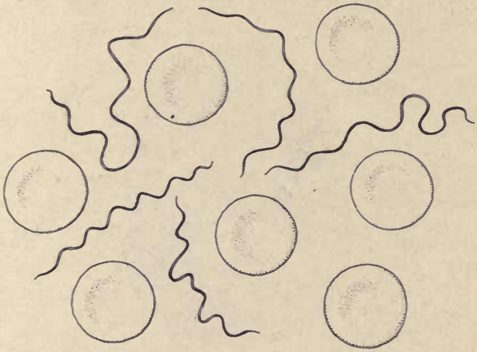

FIG. 13.—ORGANISMS OF AFRICAN RELAPSING FEVER, *Spirochaeta duttoni*, and red blood-corpuscles; × 1,500.

The larval stage of the tick is not well developed in this species, and is inert, the tick emerging from the eggshell as a nymph. After freeing itself from the larval skin, the nymph is ready to feed. It casts its skin several times before becoming adult, a moult taking place after each meal of blood. The female tick does not lay eggs until it has fed on blood. The spirochaetes are taken up by the tick whilst sucking blood from an infected person. They make their way into the ovaries of the tick, penetrating into the undeveloped eggs and multiplying within them. The first nymphal stage that develops from these eggs is capable of conveying the disease. The spirochaetes can be transmitted to the third generation of ticks, even if the second generation was fed on blood free from spirochaetes.

Ornithodoros savignyi is very widely distributed in Africa, from Egypt to Cape Colony, and is also recorded from Southern India. It occurs on both man and domestic animals, and experiments have shown that the species is capable of transmitting the human relapsing fever of tropical Africa.

Dermacentor venustus is a North American form, ranging from British Columbia southwards to Ncrthern New Mexico, and from the foothills of the Rocky Mountains in Colorado to the base of the Cascade Range, in Oregon and California (see map). Almost all the small mammals found in the localities in which this tick occurs serve as hosts for the larvae and nymphs. The adult tick is

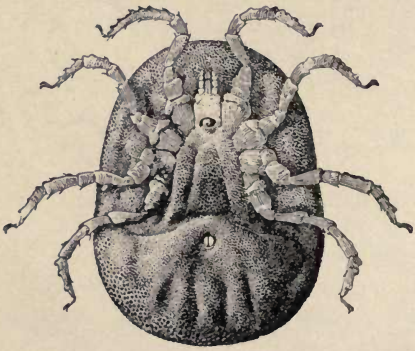

FIG. 14.—AN AFRICAN TICK,

Ornithodoros moubata, female, under surface, × 4; largely responsible for the spread of the relapsing fever of Africa.

nearly always met with on the larger domestic animals, especially on horses and oxen. The species also attacks man, and transmits the spotted fever of the Rocky Mountains, a disease with a high rate of mortality. According to some authorities, more than one species has been included under the name *D. venustus*, and the species conveying Rocky Mountain fever should be called *D. andersoni* Stiles.

The second group exhibited comprises examples of ticks that convey disease to domestic animals, but not to human beings; it includes the following species:—

Rhipicephalus evertsi Nn. is a tick found in most parts of Africa (see map), and transmits East Coast fever of cattle and the

South African biliary fever of horses. It is known to attack oxen, sheep, horses and dogs, and has also been met with upon antelopes, giraffes and elephants.

Ixodes ricinus Linn. is apparently the chief carrier of redwater fever, a form of piroplasmosis, in cattle in Northern Europe. It ranges through Europe, North Africa, Transcaucasia, Arabia, China, Japan and North America. It is met with upon sheep, cattle, goats, horses, dogs, deer, hedgehogs, and many other mammals, also lizards, and occasionally on man.

Amblyomma hebraeum Koch is known as the bont tick; it is a common species in South Africa, and is distributed as far as Central Africa. Owing to the fact that it transmits heartwater in sheep, goats, and sometimes in cattle, this tick is of considerable importance to agriculturists. Further remarks upon the bont tick are given below.

The third group includes examples of ticks that are not known to convey disease to man or other vertebrates; three species are shown, as follows:—

Amblyomma cohaerens Dönitz is found in Uganda upon buffaloes.

Dermacentor rhinocerotis de Geer ranges from South Africa to Uganda and British East Africa, and is found usually upon the rhinoceros, but sometimes on antelopes.

Dermacentor circumguttatus Nn. is met with upon elephants in Uganda and West Africa.

In one of the table-cases in the middle of the floor of the Hall is a series of specimens and enlarged models of the bont tick, *Amblyomma hebraeum* Koch, an African tick parasitic upon sheep, goats and oxen. The exhibited series includes a drawing of a small group of eggs, a model of a larva enlarged to the same size as the models of the adult, namely 20 diameters, and another model of the same larva still further enlarged ($\times$ 120) to show the details of structure. Models are shown of an adult male and female ($\times$ 20), and actual specimens are mounted on the tablet between them. The great model in the middle of the case represents the female when fully gorged and distended with blood and eggs, magnified to the same extent ($\times$ 20). Two actual specimens of gorged females, of the size of cherries, are shown in the small glass vessel of alcohol.

The bont tick is capable of transmitting to sheep, goats and

oxen the deadly disease known as heartwater, when it bites a healthy animal after having fed upon one that is suffering from the disease. The organism that causes the disease has not been seen in the blood of the vertebrate host, but experimental investigation shows that it is not transmitted through the egg of the tick as are some other tick-borne blood-parasites of the genera *Piroplasma* and *Spirochaeta*.

The larva, nymph and adult of the bont tick feed on three different individual hosts, dropping to the ground after each meal; the organisms imbibed with the blood of an infected host by the larva are transmitted to the second host by the nymph; and similarly, if a nymph feeds on an infected host it may, when adult, transmit the organisms to the third host. Mating of the ticks occurs on the skin of the third host, and the female then feeds until fully gorged; afterwards it drops to the ground, and in course of time produces a vast number of eggs.

INDEX.

GUIDE-BOOKS.

(*The Guide-books can be obtained at the Museum. Postage extra.*)

General Guide to the Museum, 8vo. 3*d*.
Guide to the Races of Mankind (Anthropology), 8vo. 4*d*.
———— Galleries of Mammals, 8vo. 9*d*.
———— Great Game Animals, 8vo. 1*s*.
———— Elephants (Recent and Fossil), 8vo. 6*d*.
———— Horse Family, 8vo. 1*s*.
———— Domesticated Animals (other than Horses), 8vo. 6*d*.
———— Whales, Porpoises, and Dolphins (order Cetacea), 8vo. 4*d*.
———— Gallery of Birds, 4to. 2*s* 6*d*.
———— General Series of Birds, 4to. 6*d*.
———— Nesting Series of British Birds, 4to. 4*d*.
———— Gallery of Reptilia and Amphibia, 8vo. 6*d*.
———— Gallery of Fishes, 8vo. 1*s*.
———— British Vertebrates, 8vo. 1*s*.
———— Insect Gallery, 8vo. 1*s*.
———— Crustacea, Arachnida, Onychophora and Myriopoda, 8vo. 1*s*.
———— Shell and Starfish Galleries, 8vo. 6*d*.
———— Coral Gallery, 8vo. 1*s*.
———— Fossil Remains of Man, 8vo. 4*d*.
———— Fossil Mammals and Birds, 8vo. 6*d*.
———— Fossil Reptiles and Fishes, 8vo. 9*d*.
———— Fossil Invertebrate Animals, 8vo. 1*s*.
———— Mineral Gallery, 8vo. 1*d*.
The Student's Index to the Collection of Minerals, 8vo. 2*d*.
An Introduction to the Study of Minerals, with a Guide to the Mineral Gallery, 8vo. 6*d*.
———————— to the Study of Rocks, 8vo. 6*d*.
———————— to the Study of Meteorites, 8vo. 1*s*.
Guide to Sowerby's Models of British Fungi, 8vo. 4*d*.
———— Drawings of Field and Cultivated Mushrooms, and Poisonous or Worthless Fungi, 8vo. 1*s*.
———— the British Mycetozoa, 8vo. 3*d*.
List of British Seed-plants and Ferns, 8vo. 4*d*.
Special Guides: No. 2. History of Plant Classification, 8vo. 4*d*.
———————— No. 5. Exhibition of Bible Animals, Plants, and Minerals, 8vo. 6*d*.
———————— No. 6. Flight Exhibition, 8vo. 6*d*.
Handbook of Instructions for Collectors, 8vo. 1*s*. 6*d*.; or in eleven separate sections, at 3*d*. or 4*d*. each.
The House-Fly as a Danger to Health, 8vo. 1*d*.
The Louse and its Relation to Disease, 8vo. 1*d*.

CATALOGUES (Selection).

History of the Collections:—
Vol. I. Libraries; Botany; Geology; Minerals. 1904, 8vo. 15*s*.
Vol. II. Zoology. 1906, 8vo. £1 10*s*.
Vol. II. Appendix. By Dr. A. Günther, F.R.S. 1912, 8vo. 5*s*.
Catalogue of the Library of the British Museum (Natural History). Vols. I.–V. 1903–15, 4to. £1 each.
Report on the Zoological Collections made . . . . during the Voyage of H.M.S. 'Alert,' 1881–82. 54 Plates. 1884, 8vo. £1 10*s*.
Report on the Collections of Natural History made in the Antarctic Regions during the Voyage of the 'Southern Cross.' 53 Plates. 1902, roy. 8vo. £2.
Reports on the Natural History of the 'Discovery' National Antarctic Expedition, 1901–4:—
Vol. I. Geology. 10 Plates, 72 Text-figures, 2 Maps. 1907, 4to. £1 10*s*.
Vol. II. Zoology (Vertebrata: Mollusca: Crustacea). 33 Plates, 146 Text-figures, 1 Map. 1907, 4to. £3.
Vol. III. Zoology (Invertebrata) and Botany (Marine Algæ: Musci). 51 Plates, 8 Text-figures, 1 Chart. 1907, 4to. £2 10*s*.
Vol. IV. Zoology (various Invertebrata). 65 Plates, 1 Text-figure. 1908, 4to. £1 15*s*.
Vol. V. Zoology (Vertebrata and Invertebrata) and Botany. 28 Plates, 19 Text-figures. 1910, 4to. £1 10*s*.
Vol. VI. Zoology (Invertebrata) and Botany. 8 Plates, 1 Key-plate, 1 Text-figure. 1912, 4to. 16*s*.
First and Second Reports on Economic Zoology. Text illust. 1903–4, roy. 8vo. 6*s*. each.

Catalogue of Monkeys, Lemurs, and Fruit-eating Bats. 21 Woodcuts. 1870, 8vo. 4*s*.

——— Chiroptera (Bats). Vol. I. Megachiroptera. 85 Text-figures. 1912, 8vo. £2 10*s*.

——— Carnivorous Mammalia. 47 Woodcuts. 1869, 8vo. 6*s*. 6*d*.

——— Seals and Whales. 2nd Edition. 101 Woodcuts. 1866, 8vo. 8*s*.

——— ——— Supplement. 11 Woodcuts. 1871, 8vo. 2*s*. 6*d*.

——— Ruminant Mammalia (Pecora). 4 Plates. 1872, 8vo. 3*s*. 6*d*.

——— Ungulate Mammals. Vols. I.–IV. Text illust. 1913–15, 8vo. 7*s*. 6*d*. to 10*s*. 6*d*. a volume.

Monograph of the Okapi. Atlas of 48 Plates, with Explanations, &c. 1910, 4to. £1 5*s*.

Catalogue of Marsupialia and Monotremata. 28 Plates. 1888, 8vo. £1 8*s*.

——— the Mammals of Western Europe. 213 Text-figures. 1912, 8vo. £1 6*s*.

——— the Heads and Horns of Indian Big Game bequeathed by A. O. Hume, C.B., to the British Museum (Natural History). 16 Text-figures and a portrait. 1913, 8vo. 2*s*.

——— Birds. Vols. X.–XXVII. Woodcuts and Coloured Plates. 1885–98, 8vo. 14*s*. to 36*s*. a volume. (*Vols. I.–IX. out of print.*)

General Index to a Hand-list of the Genera and Species of Birds. 1912, 8vo. 10*s*.

Catalogue of Birds' Eggs. Vols. I.–IV. Coloured Plates. 1901–12, 8vo. £1 5*s*. to £2 7*s*. 6*d*. a volume.

——— Lizards. 2nd Edition. Vols. II., III. Plates. 1885–87, 8vo. 20*s*. and 26*s*. (*Vol. I. out of print.*)

——— Snakes. Vols. I.–III. Woodcuts and Plates. 1893–96, 8vo. 17*s*. 6*d*. to £1 6*s*. each.

——— Fishes. 2nd Edition. Vol. I. Woodcuts and 15 Plates. 1895, 8vo. 15*s*.

——— the Freshwater Fishes of Africa. Vol. I. 270 Text-figures. 1909, imp. 8vo. £1 12*s*. 6*d*.—Vol. II. 382 Text-figures. 1911, imp. 8vo. £2 5*s*.—Vol. III. 351 Text-figures. 1915, imp. 8vo. £2 5*s*.

——— The British Species of Pisidium (Recent and Fossil). 30 Plates. 1913, 8vo. 10*s*. 6*d*.

——— Spiders of Burma. 1895, 8vo. 10*s*. 6*d*.

A Revision of the Ichneumonidæ. Parts I–IV. 1912–15, 8vo. 4*s*. to 6*s*. a part.

Monograph of Culicidæ, or Mosquitoes. Vols. IV., V. Woodcuts and Plates. 1907–10, 8vo. £1 12*s*. 6*d*. and £1 5*s*. a volume. (*Vols. I.–III. out of print.*)

Handbook of Tsetse-Flies. 10 Coloured Plates, 24 Text-figures, and a Map. 1911, roy. 8vo. 5*s*. 6*d*.

Illustrations of British Blood-sucking Flies. 34 Coloured Plates. 1906, roy. 8vo. £1 5*s*.

Catalogue of Lepidoptera Phalænæ (Moths). Vols. I.–XIII. Woodcuts and Atlases of Coloured Plates. 1898–1913, 8vo. £1 5*s*. to £2 2*s*. 6*d*. a volume (including the Plates).

——— Orthoptera. Vols. I.–III. 1904–10, 8vo. 10*s*. to £1 a volume.

——— Homoptera. Part I. Cicadidæ. 1906, 8vo. 5*s*.

——— British Hymenoptera. 2nd Edition. Part I. New Issue. 11 Plates. 1891, 8vo. 6*s*.

——— Chætopoda. A Polychæta: Part I.—Arenicolidæ. 15 Plates. 68 Text-figures. 1912, roy. 8vo. £1 7*s*. 6*d*.

——— British Echinoderms. Woodcuts and 16 Plates. 1892, 8vo. 12*s*. 6*d*.

——— Madreporarian Corals. Vols. I.–VI. Plates. 1893–1906, 4to. 18*s*. to 35*s*. a volume.

Illustrations of Australian Plants collected in 1770 during Captain Cook's Voyage round the World in H.M.S. 'Endeavour.' Part I. 101 Plates. 1900, fol. £1 5*s*.—Part II. 142 Plates. 1901, fol. £1 15*s*.—Part III. 77 Plates and 3 Maps. 1905, fol. £1 5*s*.

Synopsis of British Basidiomycetes. 5 Plates and 145 Text-figures. 1908, 8vo. 10*s*.

Monograph of British Lichens. Part II. 59 Plates. 1911, 8vo. £1.

——— the Mycetozoa. 2nd Edition. 201 Plates and 56 Woodcuts. 1911, 8vo. £1 10*s*.

The above-mentioned Catalogues may be purchased of Messrs LONGMANS, GREEN & Co., 39, *Paternoster Row*; Mr. B. QUARITCH, 11, *Grafton Street, New Bond Street*; and Messrs. DULAU & Co., LTD., 37, *Soho Square*; or at the NATURAL HISTORY MUSEUM, *Cromwell Road, London, S.W.* A more detailed list may be obtained on application to the DIRECTOR of the Museum.

May to August (inclusive)	„	2.30	„	7	„
September	„	2	„	5.30	„
October	„	2	„	5	„
November and December	„	2	„	4	„

The Museum is closed on Good Friday and Christmas Day.

By Order of the Trustees,

L. FLETCHER,

Director.

LONDON: PRINTED BY WILLIAM CLOWES AND SONS, LTD., DUKE STREET, STAMFORD STREET, S.E.